AD-A104 585   NAVAL POSTGRADUATE SCHOOL MONTEREY CA   F/G 17/2
THE MESSAGE PROCESSING AND DISTRIBUTION SYSTEM DEVELOPMENT.(U)
JUN 81 K L WHITTEN

UNCLASSIFIED   NL

1 of 1
AD
A104585

END
DATE
FILMED
10 81
DTIC

NAVAL POSTGRADUATE SCHOOL

Monterey, California

THESIS

THE MESSAGE PROCESSING AND DISTRIBUTION SYSTEM DEVELOPMENT

by

Kenneth Lee Whitten

Jun[redacted]81

Thesis Advisor: Lyle Cox

Approved for public release; distribution unlimited.

Unclassified

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER	2. GOVT ACCESSION NO. AD-104 585	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) The Message Processing and Distribution System Development		5. TYPE OF REPORT & PERIOD COVERED Master's Thesis; June, 1981
		6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s) Kenneth Lee Whitten		8. CONTRACT OR GRANT NUMBER(s)
9. PERFORMING ORGANIZATION NAME AND ADDRESS Naval Postgraduate School Monterey, California 93940		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS
11. CONTROLLING OFFICE NAME AND ADDRESS Naval Postgraduate School Monterey, California 93940		12. REPORT DATE June, 1981
		13. NUMBER OF PAGES 54
14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office)		15. SECURITY CLASS. (of this report) UNCLASSIFIED
		15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)

Approved for public release; distribution unlimited.

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

MPDS, Message Processing and Distribution System, System Development, Integrated Logistic Support

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

This thesis provides a critical analysis of the Navy's Message Processing and Distribution System (MPDS) development. A historical approach is used in presenting the system's life cycle development beginning with the planning phase and ending with the integrated logistic support phase. Several maintenance problems which occurred after the system was accepted for Fleet use were examined to determine if they resulted from errors in the acquisition process. The underlying intent of the thesis is to use the MPDS to examine the critical decision

points of the acquisition process and offer constructive recommendations for avoiding the problems which hindered the successful development of this system.

Accession For	
NTIS GRA&I	☑
DTIC TAB	☐
Unannounced	☐
Justification	
By	
Distribution/	
Availability Codes	
Dist	Avail and/or Special
A	

Approved for public release; distribution unlimited.

The Message Processing and Distribution

System Development

by

Kenneth L. Whitten
Lieutenant, United States Navy
B.A, University of South Alabama, 1973

Submitted in partial fulfillment of the requirements for the degree of

MASTER OF SCIENCE IN INFORMATION SYSTEMS

from the

NAVAL POSTGRADUATE SCHOOL
June 1981

Author: K. L. Whitten

Approved by: Dale A. Cox Jr.

Thesis Advisor

Norman R. Lyons

Second Reader

Chairman, Department of Administrative Sciences

W M Woods

Dean of Information and Policy Sciences

ABSTRACT

This thesis provides a critical analysis of the Navy's Message Processing and Distribution System (MPDS) development. A historical approach is used in presenting the system's life cycle development beginning with the planning phase and ending with the integrated logistic support phase. Several maintenance problems which occurred after the system was accepted for Fleet use were examined to determine if they resulted from errors in the acquisition process. The underlying intent of the thesis is to use the MPDS to examine the critical decision points of the acquisition process and offer constructive recommendations for avoiding the problems which hindered the successful development of this system.

<u>TABLE OF CONTENTS</u>

I. INTRODUCTION

The purpose of this thesis is to analyze the pertinent aspects of development and life cycle support of the Navy's Automated Message Processing and Distribution System (MPDS). The historical section will discuss the imperative need to automate the Navy's communication systems. It will then explain the Navy's decision to begin developmental effort to automate many of the manual communications functions.

The development of the MPDS will next be discussed with detailed emphasis placed on the following topics:

1. Hardware Specifications
2. Software Specifications
3. Security Requirements
4. Configuration Control
5. Testing Procedures

Next, a few unique problems with system maintenance, logistic support, and training will also be examined.

Finally, cause/effect conclusions will be drawn and coupled with constructive recommendations for future major system development projects.

II. PROJECT HISTORY

A. BASELINE II COMMUNICATIONS STUDY

In October of 1966, the Commander of the First Fleet conducted a Communications Readiness Exercise to determine the Fleet's ability to handle large volumes of message traffic during simulated wartime conditions. This exercise was known as Baseline II, and it revealed the fleet was unable to handle large message volumes without encountering significant delays. These delays usually occurred in areas where humans were required to manually handle or process the messages. Two of the areas where major delays frequently occurred were identified as the Naval Communication Stations (NAVCOMSTAS) and Radio Central on board the naval ships.

The Naval Electronics Laboratory Center (NELC) in San Diego was directed to develop a system which would reduce the shipboard delays in message processing and distribution. The objective was to automate as many manual functions as possible. NELC installed the first experimental shipboard Message Processing Distribution System (MPDS) aboard the USS Oklahoma City (CG-5). This initial system was quite small and consisted of a single processor, magnetic disk storage device, and a high speed printer. Many updates and enhancements were added to this system as they became available. Several remote printers were later installed at important locations throughout the ship, but no attempt was made to add remote interactive terminals (Ref. 1) Consequently, all outgoing message traffic had to be physically deposited at Radio Central for transmission from the ship.

B. CVN-68 MESSAGE PROCESSING AND DISTRIBUTION SYSTEM

At the same time that NELC was working on the CG-5 MPDS, it began work on the fully automated MPDS destined for installation on the USS Nimitz (CVN-68). This system was to be part of the ship's original equipment, so it was extremely important that the project's completion date correspond closely to the completion of construction of the Nimitz. Had MPDS not been ready and available on time, the Nimitz would have been forced to go to sea with an extremely degraded manual communications system. Consequently, proper management of the system's development by NELC was of immense importance if the Navy's readiness objectives were to be obtained.

The Nimitz was originally scheduled to come out of construction in late 1973, but reactor delivery slippage caused several delays which resulted in a late commissioning in 1975. Since the MPDS was behind schedule, the delivery date slippage for the reactors gave NELC and Planning Research Company (PRC) badly needed additional time to correct several software problems and install the completed system onboard the Nimitz in 1974 without causing any further delays. [Ref.2]

NELC used the old aircraft carrier, USS Bunker Hill, to test the operation of MPDS in a shipboard environment [Ref. 3]. This procedure provided NELC with the opportunity to examine the effects of the shipboard electricity, excess humidity, and metallic influence upon the MPDS.

C. MAINTENANCE PHASE

In 1975 the Fleet Combat Direction System Support Activity, San Diego, (FCDSSASD), assumed system support responsibility for MPDS. During the following five years, eighteen major changes were approved and released which affected one or all of the following major systems:

1. Operating System (OS)
2. Software Maintenance System (SMS)
3. Equipment Maintenance Sub-system (EMSS)
4. System Magnetic Tape Retrieval (SMR)
   [Ref. 4]

In 1976, the Navy awarded the MPDS software maintenance contract to Syncrotech Software Corporation in San Diego. This contract was "sole source" and went to Syncrotech because they employed a great number of PRC programmers who were involved in the initial development of MPDS [Ref. 5].

D. ADDITIONAL INSTALLATIONS OF MPDS

An identical copy of MPDS was later installed aboard the USS Eisenhower (CVN-69), and a copy is presently being installed aboard the Vinson (CVN-70). In July of 1973, in response to the Chief of Naval Operations, the Naval Electronic Systems Command began a project called the Naval Modular Automated Communications System (NAVMACS). Since NAVMACS was designed to fulfill the communication needs of all Naval ships and the carrier version NAVMACS V-5 will soon be completed, no additional copies of MPDS will be produced for future carriers. NAVSEA has also authorized the installation of the NAVMAC V-5 system to replace the MPDS onboard the USS Nimitz, USS Eisenhower, and the Vinson as these ships enter their regular overhaul cycles.

III. ANALYSIS OF MPDS DEVELOPMENT PROCESS

A. HARDWARE SPECIFICATIONS

1. Available Hardware

The initial specifications required that the project office "utilize equipment units or designs which are in being and readily available"[Ref. 6]. A list of available equipment follows:

Name	Designation
Central Processor	CP-642B
Magnetic Disk	RD-281
Magnetic Tape Unit (MTU)	RD-294

The decision to use available equipment offered the possible advantage of reducing development cost because it is much cheaper to purchase additional units than it is to develop the initial units. It also helps to improve the Navy's Supply System Purchasing Office's economies of scale since it serves to increase the overall purchase volume. This procedure also conforms to the Department of Defense Standardization Program which requires the services to purchase existing equipment. Using existing equipment involves less risk, so it helps prevent cost overruns and schedule slippages. It also lessens the logistic problems which are generally associated with unique equipment items. Items which are already in the Navy stock system often have maintenance contracts established with the vendors. Unfortunately, buying existing equipment did not solve MPDS's logistic problems because the manufacturers of many of these vendors stopped producing the equipment. Therefore replacement has become increasingly difficult and equipment overhauls have become longer and more costly.

2. Hardware Development Items

Many hardware items which were required for MPDS were not available in the naval stock system and had to be contracted out for development. Several of the major equipments which had to be developed include:

Name	Designation	Contractor
Line Printer	TT 624	Data Products
Magnetic Drum	MU 570	RCA
Display Keyboard	AN/UYA-9	Burroughs

The Data Accumulation and Distribution Unit (DADU) was a very sophisticated and unique piece of hardware which was developed to perform the system multiplexor function for MPDS [Ref. 7]. The Electronic Switching Unit (ESU) was another unit which had to be developed to allow all three processors access to the magnetic disk. The ESU has proven to be very reliable, but its failure would restrict two of the three processors from accessing the single disk. The ONI-43 is a device used to interface MPDS with the fleet satellite broadcast, Common User Digital Information Exchange Subsystem (CUDIX). This device was developed after MPDS was accepted for fleet use, and it became apparent that MPDS required a backup system which would provide broadcast support during periods of major equipment failures.

3. Equipment Specifications

General requirements for all equipment developed for MPDS are referenced in the specification document [Ref. 8]. Military standards were referenced which set equipment requirements for temperature, shock, resistance, low level signaling and reliability [Ref. 9]. Functional specifications for the hardware included processing rates required, code which it must be capable of processing, security requirements, and other general functional requirements.

4. Areas Not Specified

Difficulty meeting several of the original specifications arose because the Navy was setting standards for new equipment which was destined for shipboard use and had to perform functions which had not existed prior to the project. Consequently, numerous changes were proposed and made to the original specifications as the program effort progressed and the contractors experience improved in the new development.

Many of the items which were developed for the project clearly lacked detailed specifications, so it was left to the personnel in the program office and the contractors to work out the details. The result was a description of what had been built rather than a specification of what was to be developed [Ref. 10]. Lack of specifications offered the advantage of allowing the program office and contractors the opportunity to make important changes to the system's design which frequently resulted in improved system performance.

One change which improved system operation was the relocation of terminals in Radio Central. Originally, two terminals were to be used for control and placed at the control console with another terminal placed in a maintenance area. The program office altered the arrangement by placing all three terminals at the control console, and this greatly improved the reliability of the control system because the AN/UYA-9 terminals have experienced a low mean time between failure (MTBF) and a high mean time to repair (MTTR) [Ref. 11].

Lack of specifications also had many obvious disadvantages. It was often difficult for the contractor and program office to know when a development was actually finished because they had nothing to compare the finished product against [Ref. 12]. It proved to be a problem with the program sponsors because they would complain that "the Navy was not getting what it originally asked for" [Ref. 13]. Allowing the project office the freedom to design the system where specifications did not exist tended to encourage configuration confusion. It is vitally important that a clear design pattern be outlined in the specification to prevent the developmental effort from wandering off course. A detailed initial set of specifications would have resolved this conflict.

B. SOFTWARE SPECIFICATIONS

The original specifications required all software to be "modular in design such that addition, deletion, or change of function be made with a minimum of reprogramming" [Ref. 14]. The requirement that the software be modular in design was fulfilled by the contractors. However major problems with adding modules and changing functions have occurred during the maintenance phase because of excessively high CPU core utilization. The specifications did not set utilization limitations upon the amount of core which the programs were permitted to consume. The requirement for the contractor to meet performance specifications did serve to limit the amount of core which should be used and still meet performance objectives, but allowances were not made for future growth and program enhancements [Ref. 15].

1. Manual Security Measures

The Informational Security System Design for MPDS was extremely important because MPDS completely changed the structure of shipboard message handling and this created numerous new security concerns. Prior to MPDS, security was provided by the thick metal and heavy security doors around Radio Central. Distribution security was accomplished by restricting access to those individiuals who were designated in writing by their department heads. An up-to-date list of these personnel with their names, security clearances, and the highest level of message classifications that they were authorized to receive was continuouosly maintained at radio central. This listing was checked any time an individual requested message distribution.

2. Automated Security Measures

After MPDS, one method of providing additional protection which was identified in the specifications was a coded device which would be used at the remote terminals to inform the control console of the classification level of the terminal [Ref. 16]. A security card reading device was never developed, but a manual code entry device was developed whereby the user could type in his classification code and have messages and reports distributed to his terminal at the appropriate classification level.

The project Office was afforded considerable latitude in developing a software system which was able to check the validity of the codes entered at the terminals. An operating system security module was developed which compared the code of the user to a Master Security List (MSL). The MSL contained a listing of all the authorized users, their codes and the levels of security which they were cleared to access [Ref. 17]. The specifications also required special acknowledgement for receipt of top secret materials. Additionally, the completed MPDS provided a top secret disclosure sheet to assist the authorized recipient in maintaining tight control over the sensitive document.

3. Operating System Security Options

Unfortunately, the projects software specifications did not address in detail several other new security concerns which were encountered in the new message handling system. One critical aspect of the software development which was not addressed specifically was the security protection to be provided by the operating system. Since operating systems vary widely in the amount of protection which they provide for their data, it is prudent to specify the exact features that are desirable to be included in the system to be developed.

IBM marketed a protection mechanism in its operating systems called "locks" which served to prevent unauthorized read/write accesses to secure blocks of memory. IBM also used the supervisor/problem mode to distinguish between users and executive states. This differentiation helped prevent unauthorized alterations of instructions, storage protection locks, and the operating system [Ref. 18].

The Multics operating system which was developed by Honeywell Information Systems offered one of the most advanced security systems in production. It offered several sophisticated features which were not available on IBM Systems. One important component was the internal password encryption which served to prevent illegal disclosure of the master password list. This protection was accomplished by encrypting the password which the user entered and comparing it against the internal password file. Therefore if a subversive agent were able to gain access to the computer and capture the internal password file, it would be of little value to him without the encryption code. A second important aspect of the Multics Security System was the use of audit trails to keep a record of the users who accessed the classified data. [Ref. 19]. This procedure is extremely effective when the users review the audit trail on a regular basis and compare it against their access logs.

4. System Vulnerability

Security safeguards are particularly important in a multiprogramming/multiprocessing environment where the processors are required to handle multiple processes at the same time. These processes will usually have different security values and will be sharing the same system resources. A system or device which can guarantee complete isolation and protection of the secure process from unauthorized access or disclosure has not been developed. Even the Multics system which was designed with security as one of its primary objectives was penetrated by a special U.S. Air Force Tiger Team who was tasked to assess the security of the computers used by the Air Force. Security patches were used to correct the security weaknesses which were discovered by the team, but these patches didn't prevent the Tiger Team from making additional penetrations by exploiting other system weaknesses [Ref. 20].

Attempts to upgrade the existing level of MPDS security to include some of the features present in MULTICS would be extremely costly and would not guarantee the security of the system. Since it is difficult to upgrade security, a program's sponsor must be very explicit in stating in the system specifications the type of security protection that is wanted.

C. CONFIGURATION CONTROL

1. FCS Specification

The control of system configuration proved to be one of the most difficult problems confronting the program office. The lack of precise specifications was one of the major reasons for uncontrolled growth in the Facility Control System (FCS). The Military Specification for the Message Processing and Distribution System for (CVAN-68) dated 30 Jan. 1967 required the following monitoring capabilities:

> 3.2.1.11 A continuous or periodic indication of suspected channel trouble shall be provided to the Facility Control Console for those channels being processed automatically.

The Specifications also provided the follow guidance on how FCS will interface with MPDS.

> 3.2.1.10 The interface between the MPDS central processor and the FCS circuit sensing multiplexer, to provide for input of the communication circuit sensing signals to the MPDS central processor, will be a standard I/O channel of the central processor.

To comply with the above guidance, the project office and contractor were forced to decide what type of sensing mechanism would be used to monitor or interrogate the channels and how often the sensing should take place. Since both the contractor and the project office wanted the best system for the Navy, they frequently elected to develop a system which offered high performance as opposed to a less elaborate system which offered marginal performance at a smaller cost [Ref. 21]. Many other decisions had to be made concerning "how to fulfill the specifications" and these eventually caused the FCS to grow in size, time, and cost.

The completed FCS would have provided many benefits to the ship's communication personnel for it would have greatly reduced the amount of manual operator intervention required for channel and terminal connections. It also would have provided an increased quality control capability which has been desired for a long time by fleet communication users.

Despite the recognized advantages in operator cost reductions and improved system reliability, the development of FCS by NELC had to be cancelled by NAVELEX because it was exceeding the original estimates for cost, resource utilization, and date for delivery [Ref. 22]. The amount of code and its corresponding core requirements had grown to such a degree that it was estimated that the completed FCS project would have required additional CP-642B central processing units if MPDS was to continue to meet the original performance specifications.

It should also be noted that the implementation of FCS would not have significantly improved MPDS' message distribution capabilities nor would it have increased the system's processing speed. The primary advavtages of FCS lie in it's improved quality monitoring and reduction in the number of operators required to manage the system. Since the primary objective of MPDS was to correct the shipboard communication deficiencies of slow message handling and poor message distribution which were revealed during the Baseline II Communications Study, it is apparent that the FCS could only be viewed as desireable excess feature.

2. Feasibility Study

a. General Approach

In June of 1970, Planning Research Company (PRC), who was NELC's software contractor for MPDS, did an Intergration of Communication System Study which included a Quality Monitoring Trade-off Study. The goal of the study was to determine the feasibility of integrating an Automatic Quality Monitoring System (AQMS) and a Frequency Monitoring System (FMS) with MPDS. AQMS and FMS were originally designed to be two subsystems of FCS. Three areas of feasibility were examined:

1. Technical
2. Cost/Benefit
3. Time

Positive conclusions were drawn about the feasibility of all three areas. PRC did recognize the interrelationships between cost and time and premised their positive time feasibility conclusions upon adequate steady funding.

PRC compared the relative ease of operating the AQMS to the labor intensive Manual Quality Monitoring System and called the difference one of the benefits. The improved accuracy was also considered a benefit. The contractor did not try to quantify the value of these benefits. The amount of risk evaluated for the project was consistently rated as low. Appendix (A) provides a listing of the additional equipment and software required to develop the AQMS and the associated degree of developmental risk [Ref. 23].

b. Cost Computation

PRC presented the following AQM cost formula in their Technical Objective VII section 2.2.3:

> Cost in the present context is that expenditure associated with the implementation of AQM expressed as a differential cost as follows:
>
> $C = C_{AQM} - C_{MQM}$
>
> where
>
> C_{AQM} = total integrated FC system cost
>
> C_{MQM} = present FC system cost

As shown above, the cost for AQMS was determined by subtracting the cost of the old manual system from the estimated cost of the automatic system. These costs were identified in Appendix (B). The exhibit provides a detailed listing of the additional hardware and software required to develop the automatic system and the estimated cost associated with each item.

c. Additional Cost Factors

In addition to the three feasibility studies mentioned above, it would have been beneficial to include a section of study on organizational feasibility. This section would quantitatively evaluate the difficulties which the organization (ship) could expect when implementing the proposed system.

The cost of implementation can become quite severe if the sailors view the new system as a threat to their security. These feelings often develop because the sailor was not trained in the operation of the new system, and he feels his position of knowledge and authority is in jeopardy. The sailors may respond to the perceived threat with either passive or active resistance [Ref.24]. Any resistance to a new system will invariably cause both delays in implementation and increases in the final project cost.

Although it is often difficult to accurately anticipate the exact amount of resistance which will be encountered and the resulting cost, an attempt must be made if the project costs estimated are to reasonably resemble the actual cost. MPDS experienced its share of operator and maintenance personnel passive resistance, and it is reasonable to conclude that the FCS would also have been received by the ship's crew with mixed feelings.

A comprehensive cost/benefit analysis would also have estimated the cost of training the fleet sailors to operate and maintain the proposed system. Appendix (B) and Appendix (C) do not address these costs. These areas had the potential to become very costly for several reasons. The fact that the FCS project was unique to the large (CVN-68) class carriers would have made some additional training activities necessary. New instructors would have to be trained, class training plans and lessons would have to be prepared, and training materials would have to be purchased. All of these efforts and expenses would have been for very small classes and would have to be completed before qualified personnel could be sent to the ship to operate the new system.

PRC's method of computing the cost by subtracting the cost of the MQM from the cost of the AQMS may not have revealed the full cost difference because AQMS was designed to utilize existing MPDS equipment. This utilization imposes a cost upon the entire system in the form of either reduced performance or smaller reserve capacity available for future growth.

In order for the Navy to have made a completely knowledgeable decision about the feasibility of the proposed project, it would have been necessary to identify all of the costs, (including cost of using existing systems), and to assign quantifiable values to the benefits.

3. Report Generator

Another area of the MPDS project development which experienced excessive growth was that of reports which were generated or could be retrieved at the remote locations. The military specifications addressed this issue in several locations.

> 3.2.1.9 Storage and retrieval capabilities for long-term files shall be provided.
>
> 3.2.2.2.5.1 It shall be possible to retrieve all or selected portions of the log information either on demand, in which the operator inputs a request to the system by keyboard, or periodically, in which case the log information is output without operator information. Both hard-copy and soft-copy retrievals shall be possible.

The following portion of the specifications provides a general framework for the types of information which the system would be required to accumulate and disseminate:

> 3.2.2.2.5 Automated message accounting shall include:
> (a) Attachment of unique system message numbers for accounting and retrieval purposes.
> (b Journalling of messages for accounting purposes.
> (c) Extracting of statistical data from message traffic.
> (d) Special accounting for top secret message delivery.

To determine the type of reports required and the elements of data which have to be accumulated and stored, the project office consulted with the users. That which resulted was a system which was originally developed to produce 47 different reports [Ref. 25]. This placed a heavy burden upon the entire system and greatly increased the amount of secondary storage required by the system. These reports were printed at periodic intervals but could also be retrieved upon demand by the users at their terminals, provided the requested information was within the security range of the user's terminal. Initially, every user could retrieve any report contained within the system. Since retrieval of long routine reports during peak message loading periods severely degraded overall system performance, and a genuine need to know could not be substantiated from a terminal retrieval request, future changes to MPDS restricted report production to scheduled runs unless special off-line requests were submitted and approved [Ref. 26].

Recent software changes which have been released to the fleet have corrected many of the problems with the initial report package. These changes have limited both the content and distribution of several periodic reports. Surveys of the fleet user groups have resulted in adding important tracking programs which generate reports on various aspects of system performance.

One, recently added, provides critical information to the Communication Officer about system message volume during peak loading periods. This data was either missing in the original 47 reports or it was obscurely buried where it could not be used or readily accessed by personnel who needed the information [Ref. 27]. It became evident that the initial querying of the users produced an inaccurate composite of their requirements. The reports which MPDS produced resembled what the user thought that they wanted rather than what they truly needed.

This lack of user understanding of his actual requirements became apparent in the development of the UI-9 remote receiver/transmitter user terminal. Seventeen functional buttons were designed into the terminals to satisfy the users' requirements. Usage patterns have shown that the operators seldom use more than six of the functions. Five of the other functions were used by the maintenance personnel. The net result was six user specified functional capabilities designed into the system terminals which were not productively utilized [Ref. 28].

D. TESTING

1. Broadcast Screening Test Objectives

Special testing of the MPDS broadcast screening capability was conducted by Naval Electronic System Command Southwest Division (NAVELECSYSCOMSOWESTDIV) at the MPDS test bed at NELC on May 14, 15, 16 and 18, of 1973. The total test time was 28 hours. Excerpts of real world live traffic were taken from four different geographic broadcast areas in the Atlantic, Eastern Pacific, Western Pacific, and the Mediterranean. The primary objective was to test the system's ability to correctly compare the addresses of the various broadcast messages against the addresses contained in the MPDS guard list (GML). The GML contained approximately 150 addresses [Ref. 29]. A second test objective was to determine how accurately the system could automatically read and distribute the incoming message to the appropriate remote terminal.

2. System Inprovement Tests

Several System Improvement Tests (SIT) were also conducted by NAVELECSYSCOMSOWESTDIV. These SIT's were given to evaluate the effectiveness of modifications made to the hardware/software subsystem. Numerous modifications were made to the system for the purpose of resolving Problem Work Sheets [Ref. 30].

3. Users Involvement in Testing

The Broadcast Screening Test and SIT both used Nimitz (CVN-68) crew members to operate the system. Utilizing the future operators of the system for test operations provides many advantages to the project team. First it provides them with an excellant opportunity to train the future users in the proper operation of the equipment. It is also an excellant opportunity to instill in them valuable confidence in the system. This confidence can be a very important advantage to the project team during the implementation phase [Ref. 31]. The spirit of cooperation and friendship which often developes between the developer and fleet operators during the testing phase can go a long way toward over coming the skepticism and resistance which often plagues projects in later phases. Finally, the project team can receive important feedback from the operators concerning operational difficulties and constructive suggestions for system improvements.

4. Restrictive Testing Procedures

Although the primary objective of testing the broadcast screening capability of MPDS was fulfilled, the results of the test were obtained under very restricted conditions. Had they been obtained under simulated or actual operational conditions, then the project team would have known how the system would function when it encountered the technical and human stresses associated with fleet operations [Ref. 32]. Message and report retrievals are two operations which significantly increase the stress upon the system. Neither of these functions were permitted during the Broadcast Screening Test. Experience has shown that the combined effect of these two processes can seriously reduce the overall effectiveness of system performance.

IV. INTEGRATED LOGISTIC SUPPORT

A. SUPPORT ACTIVITIES

1. FCDSSASD

In 1975 FCDSSASD was originally tasked to provide life cycle maintenance for the Message Processing and Distribution System. To facilitate this support, a special suite of equipment, (identical to the MPDS equipment onboard USS Nimitz), was installed at FCDSSASD [Ref. 33].

2. NTSIC

In 1979 the Naval Telecommunications Systems Integration Center (NTSIC) assumed life cycle maintenance responsibilities for MPDS [Ref. 34]. NTSIC has a duplicate model of the MPDS hardware and software which is presently onboard the USS Nimitz and USS Eisenhower. This model serves as a testing facility for all new software modification and hardware changes before they are delivered to the fleet for installation.

NTSIC also serves as coordinator for all software change proposals (SCP) [Ref. 35]. A sample list of SCP candidates for MPDS software change release #10 is shown in Appendix (D). This list was developed by sending questionnaires to the fleet users and compiling the results. The candidates for change were then discussed with the senior communications personnel from the carriers prior to the meeting of the Communications Change Control Board (CCB). Only change items which received unanimous user support and agreement were forwarded to the formal (CCB). Final Commander Naval Telecommunications (CNTC) approval for software changes is based upon the outcome of the board. NTSIC is intimately involved with every step of this process [Ref. 36].

3. Syncrotec Software Corporation

The MPDS software maintenance contract was awarded to Syncrotec from San Diego. The fact that many of the original MPDS software development programmers left Planning Research Corporation (PRC), (the original software contractor), and went to work for Syncrotec weighed heavily in the decision to select them as the software maintenance contractor. Since MPDS had unique software to perform difficult applications, it was important to choose a software maintenance corporation which had experience with the system.

B. TRAINING

1. Initial Training

Commander Franson, who is the Deputy Director of NAVTELSYSIC, described the first training of the Nimitz's precommissioning crew as being very successful. This was due in part to the high priority that the project team placed upon utilizing every training opportunity. The Execution Plan for Operational Capability Evaluation (OPCAPEVAL) stated the following training objective:

> " Every effort will be made to make the MPDS available to the Nimitz crew for training during contingency period."

This training was in addition to practical experience which the crew members obtained while operating and maintaining the equipment during the scheduled test periods. Appendix (E) provides a schedule of events which occurred during the OPCAPEVAL and the long periods designated for system training [Ref. 37].

2. Operational Training Problems

After the system had been implemented and the USS Nimitz became operational, training deficiencies began to surface. These deficiencies became especially evident when the USS Nimitz made her overseas deployments. In a trip report from two Synchrotec software technicians, the following comments were made concerning training [Ref. 38]:

> "The lasting impression that remains with us however, is that the weakest link in the operation and performance

> of MPDS is now unquestionably the operators themselves. Knowledge of basic communications procedures and practices (let alone, knowledge of MPDS) was sadly lacking among many of the second and third class petty officers aboard ship, and until the sailors are familiar with how to communicate in the Navy environment, we can hardly expect them to become proficient at operating MPDS."

This concern about the level of shipboard personnel training was also shared by the officers onboard the USS Nimitz. In a message to the Commander of the Sixth Fleet (COMSIXTHFLT), the Commander of Task Force Sixty (CTF SIX ZERO) made the following comments [Ref. 39]:

> "There is no software expertise onboard Nimitz capable of providing the level of support that recent operations have documented as required to maintain MPDS in even a marginally operational status. . . . The onboard software techs should be relieved by a technician qualified in system restoral and installation of system fixes.

It is clear from the above statements that the shipboard technicians lacked understanding about how MPDS operated and how to maintain the system. This leads to the obvious question of how did the USS Nimitz's training profile drop from its initial high state to one which can barely maintain operational capability.

3. Scarcity of Instructors

The Commander of Naval Education and Training (CNET), who is in charge of training conducted in the Navy, had extreme difficulty finding qualified instructors to teach MPDS operator and maintenance classes. There are several reasons why this problem developed.

a. The Commissioning of the Eisenhower

When the Eisenhower got commissioned, it required a full compliment of qualified operators and maintenance technicians to take her to sea. Her precommissioning crew did not have the advantage of being able to participate in the system development of MPDS as the Nimitz precommissioning had done. Consequently, they were not as well trained, and qualified personnel had to be acquired from either the Nimitz or ashore. Since the training command had second priority to fleet units for personnel manning, CNET could not obtain or retain the instructors that it needed to conduct MPDS classes [Ref. 40].

b. Sea/Shore Rotation Problems

The shortage of trained personnel combined with the expanding need for sailors who possessed MPDS operation and maintenance experience caused a serious extension of the normal sea/shore rotation interval. A sailor could routinely expect to receive orders from the USS Nimitz to the USS Eisenhower rather than the typical rotation ashore which most sailors have grown to expect. The net effect of this extension at sea has been a severe reduction in the number of qualified personnel staying in the Navy.

c. Civilian Opportunities

The third reason for CNET being short of instructors is the intense demand for individuals with high technical expertise in the civilian market. These civilian firms usually offer very high starting salaries to qualified personnel. Since MPDS technicians were generally some of our most highly trained sailors, their marketability was exceptionally high. With the rapid exodus of highly trained technicians and barely enough personnel to man the fleet units, it was not surprising that CNET was unable to provide the necessary number of instructors to conduct the courses.

4. <u>NTSIC Solution</u>

Although training is generally conducted by CNET, the lack of available instructors made it impossible for CNET to adequately train the MPDS operators and maintenance personnel. NTSIC attacked the training problem in two areas. First, they sent NTSIC MPDS specialists onboard the aircraft carriers during their deployments to train them in operating and maintaining the system under heavy stress. Secondly, they offered an 18 week maintenance course and a 9 week operators course at regular intervals to prepare sailors, who were ordered to the USS Nimitz or the USS Eisenhower, for their jobs. These courses have proven to be very beneficial in improving the ships' capability to operate and maintain the MPDS with their own personnel.

5. Alternative Design to MPDS

a. Description of NAVMACS

Many of the problems encountered in training the crews of the USS Nimitz and USS Eisenhower in the proper operation and maintenance of MPDS have not been experienced by fleet units using the Naval Modular Automated Communications System (NAVMACS). The NAVMACS program provides a family of Automated Communications Systems sized to meet the needs of all sizes of ships. The classes of NAVMACS range from the most basic NAVMACS V1 and increases in sophistication and capability through the NAVMACS V2, V3, and V5. The prime advantage of this system is that the more complex systems retain and build upon the components of the basic system. Appendix (F) provides an example of how the more advanced systems utilize the standard hardware of the simple system [Ref. 41].

b. Training Advantages of Modular Design

The above approach to system development offers several training advantages over the MPDS. The training task is much easier because sailors who are enroute to a ship which has the NAVMACS V1 basic system installed could be trained with students who are destined to serve on a NAVMACS V3 ship. This is possible because both systems share the same basic modules. The problems of small sized classes and lack of qualified instructors which troubled MPDS are not a problem with NAVMACS [Ref. 42]. CNET has been able to successfully fill its instructor billets, and the increased size of the classes has provided CNET with substantial economies of scale.

c. MPDS Replacement System

The NAVMACS V5 will offer the same basic message processing and distribution services as MPDS. It is currently scheduled to be installed on all of the future CVN's after the Vinson. It is also scheduled to replace the MPDS units on the Nimitz, Eisenhower, and Vinson, as they undergo their regular overhauls. CNET will assume training responsibilities for this system [Ref. 43].

C. MAINTENANCE

1. System Reliability Problem

System reliability is one of the greatest concerns for users of online computer systems since the primary reason for installing such systems is to satisfy the need for immediate information. This need for reliability becomes even more important when the online system is tasked with carrying tactical and strategic intelligence messages which may effect the wartime readiness posture of the host ship and any ships subordinate to it.

The problem of MPDS reliability was addressed in a letter from the Commander of Carrier Group Two (who was embarked onboard the USS Nimitz) to the Commander Naval Air Force, U.S. Atlantic Fleet.

> Erratic reliability was the primary MPDS deficiency. The fact that reliability invariably declined as traffic volume rose made unreliability a particularly sensitive problem. . . . Reliability of 99.5] is considered a reasonable standard of satisfactory performance [Ref. 45].

2. Equipment Problems

Many of the hardware items which were developed especially for MPDS became maintenance problems. Low mean time between failures (MTBF) and/or lack of replacement parts were the two primary reasons for excessive system down time. Following will be a discussion of hardware problems related specifically to the Data Acquisition and Distribution Unit (DADU) and to the MU 570 Drum:

a. The DADU

The Data Acquisition and Distribution Unit (DADU) TD 1066, which functions as an input/output control interface unit, is unique in design and is considered essential for normal operations. This unit has been a continuous maintenance concern since the system was first installed on the Nimitz in 1974. The Supervisor of Shipbuilding at Newport News, Virginia, wrote the following comments to Admiral Kidd about the need for logic and control printed circuit cards for the DADU.

> No replacement cards are available to immediately satisfy Nimitz's demands when one of these . . . cards fail, which is often. It has become apparent that little attention has been given to ensuring adequate provisioning for unique MPDS hardware [Ref. 45].

DADU failures have frequently interrupted normal shipboard message communication since its initial installation. Its breakdowns have necessitated Synchrotech maintenance specialists to take long ship rides with the USS Nimitz to fix the DADU and restore the system to normal operational capability.

Operational units were not the only activities to suffer degraded mission readiness because of the unreliable equipment. The Fleet Combat Direction Systems Support Activity which originally provided life cycle support for MPDS also experienced operational interruptions due to DADU failures. This was due primarily to the lack of complete logistic support. The failures resulted in a substantial reduction in the unit's ability to meet fleet support requirements [Ref. 46].

In March of 1978, Capt. A.B. Huff USNR, who was a hardware system engineer for Martin Marietta Company in Denver, Colorado, did an analysis of MPDS during his two weeks of active duty with the Naval Electronic Systems Command. He made the following remarks about the DADU:

> Since only four of these DADU units presently exist, the ESO procures replacement boards on an "as call basis". This creates longer than usual replacement time and costs around $1000 per card [Ref. 47].

Capt. Huff stated that an item which could serve as a replacement for the DADU is a unit called MICS. It is currently being used by the Air Force's Strategic Air Command with apparent success. The modern circuit technology used in MICS is estimated to reduce maintenance cost by as much as 90] and greatly increase reliability.

b. MU 570 Drum

MPDS was designed with two drums to provide added capacity and redundancy. The initial specifications called for a single IBM disk unit, but the contractor, Planning Research Corporation (PRC), wisely convinced the Government Project Office of the need for the increased speed which was available in the MU 570 magnetic drums [Ref. 48]. The drums have also been characterized by low MTBF and frequent logistic problem. However, the failure of one drum does not force the entire system to shut down, which is what occurs when the DADU fails. This is because the second drum is capable of supporting the system in a degraded mode.

c. General Hardware Characteristics

MPDS was designed with a tremendous amount of hardware redundancy. The system is programmed to gracefully die without interrupting normal message processing until the last spare unit collapses. This feature of MPDS is extremely valuable when the system is experiencing heavy loading while fulfilling operational commitments. During these periods, it would be very difficult to shut down the system for troubleshooting, so the designers made this procedure unnecessary by providing sufficient equipment spares to allow the system to continue to operate [Ref. 49].

3. Omissions to the Functional Description

Several maintenance problems surfaced when the fleet users discovered that the new system did not do everything that they needed. Two areas which were of particular concern to the users were message storage limitations and NATO message handling.

a. Message Storage Limitations

The Commander of Carrier Group Two, who was embarked onboard the USS Nimitz, was deeply concerned about the system's limited online message retrieval capability. He wrote the following comments in a letter to his Commanding Officer:

> The existing MPDS capacity did not provide sufficient online message storage to permit more extensive user recall of recent messages . . . hence duplicate paper files were maintained to provide copies of messages that had been removed from online storage. Ten days of online message recall capability is considered a reasonable target [Ref. 50].

Although the system was obviously not providing adequate message retrieval services, it was performing up to the standards outlined in the Functional Description. The following is the message storage requirement contained in the Functional Description:

> 3.2.1.10 System messages and associated . . . entries shall be stored for approximately three days on online mass storage to support duplicate search, message retrieval, report generation and other functions [Ref. 51].

b. NATO Message Processing

The capability to process North Atlantic Treaty Organization (NATO) message traffic was not included as part of the automated MPDS. Consequently, the USS Nimitz was required to process NATO traffic manually during a large part of her deployment to Europe [Ref. 52]. Several temporary patches were made to the system to allow for partial automated handling of NATO messages. The Commander of Task Force Sixty wrote the following to the Commander of the Sixth Fleet:

Without the partial automated NATO processing capability achieved by patches, the task (of processing all of the NATO traffic) would have been close to impossible [Ref. 53].

The Functional Description for MPDS made no requirements for NATO automatic message processing capabilities. A permanent software change to allow automatic processing of NATO messages was installed onboard the USS Nimitz after the completion of the deployment.

c. Message Traffic Estimates

Naval telecommunications message traffic has been increasing each year as the quality and speed of service has continued to improve. The Military Specifications for MPDS were written in 1967 when the average traffic volumes for aircraft carriers were much lower than what would be found in the fleet today. The following MPDS requirements are taken from the original Military Specification:

3.1.14 Data rates and capacity.--The system when operating "on-line" shall . . . be possible to handle up to 2500 average messages per day and to retrievably store up to 7500 average messages.

3.1.13 Average traffic units.--System capacity and processing rate requirements herein shall be based on an average message length of 200 words [Ref. 54].

The average length of messages has increased to above 200 words because fleet units are now sending more administrative traffic over the fleet broadcast which used to be delivered by mail.

MPDS has been required to process average message volumes in excess of 3500 messages per day when the USS Nimitz had the Task Force Commander embarked during major fleet exercises in the Mediterranean Sea [Ref. 55].

4. <u>The Effects of Operations Upon Maintenance</u>

The urgent necessity of intense fleet operations has frequently been the cause for delays in both corrective and scheduled maintenance. During the 1976 deployment of the

USS Nimitz, several hardware and software problems developed which could not be handled by the ship's maintenance crew. Synchrotech sent a software team aboard the carrier during part of the deployment to correct problems and make recommendations for system improvements. Following are a few comments made by the software specialist concerning their shipboard experience:

> It is nearly impossible to debug a software system in an operational environment, expecially with traffic volumes which are typically associated with a flag command. The system cannot be surrendered to the exclusive use of programmers to test and debug . . . an outage of even 30 minutes creates traffic backlogs untenable to the staff and ship users [Ref. 56].

It is evident from the above statement that a system with low MTBF would function more successfully in an intense operational environment. Another way of solving the maintenance problem is to design a system which offers a short mean time to repair (MTTR). Many systems are available today which are modularly constructed to allow average technicians to pull the defective module and insert a replacement module in a very short time frame.

5. Improved Reliability

MPDS has now been in the fleet for six years. During this time the operators and maintenance personnel have acquired a wealth of valuable knowledge about the system. This increased knowledge has enabled the fleet users to maintain the system in a higher state of readiness. Many of the original maintenance problems were due to the fact that it is difficult to maintain an unfamiliar system regardless of the level of technical expertise of your personnel [Ref. 57].

Synchrotech software specialists were called aboard the USS Nimitz to solve several technical problems which appeared to be beyond the technical ability of the ship's maintenance crew. The software specialist said the following about the magnetic drum failures in the trip report which they submitted:

> Magnetic drums--The message file clerks, who use a work area and table which is mounted directly in front of the drums, were stacking burn bags (bags full of old messages which are scheduled to be burned) on the floor directly in front of the drum. This restricted the badly needed air circulation required by the MU-570 drum to maintain a reasonable ambient air temperature, and the drum began experiencing intermittent errors. Removal of the bags resolved the problem [Ref. 58].

This is an example of how the operators learned valuable information about the heat sensitivity of the drums and the air circulation patterns in the computer room. This information should be available for future operators of the system and consequently further heat problems with the drums should be avoided. The net summation of these learning experiences is quite often a more reliable system.

Another factor contributing to improved performance was the installation of 18 software releases by FCDSSASD and NTSIC [Ref. 59]. These software releases have provided incremental improvements to the operating system, maintenance subsystems, and the retrieval subsystem. They have added the capability to process NATO messages, accumulate and process useful data for periodic reports, and generally improve overall system performance.

V CONCLUSION AND RECOMMENDATIONS

A. OVERVIEW

The MPDS project history has provided a classic example of how failure can occur in the military computer acquisition process. This failure was the result of the Navy not giving sufficient attention to four major elements of the acquisition process.

The first and primary problem was the Navy's failure to do detailed planning at the beginning of the project prior to initial developmental work. Inadequate time spent upon planning resulted in the project not having a well mapped course to follow. Cost over runs and problems with maintenance, training, and logistics could also be attributed to poor planning. Eighteen change releases by the Navy's system support activities were required to correct many of the problems which had their origins in the system planning phase.

Failure to freeze the design early in the project was another significant problem with the developmental process. The Facility Control System's design was permitted to change and grow until the system had to be terminated because it was going to make the entire MPDS project late and drive the total cost of the project beyond acceptable limits. Project scheduling problems developed because no one knew when the FCS would be finished since it was not known what the finished product was supposed to look like.

Ambiguous and/or incomplete military specifications also contributed to the project office's problems. The project office had to make design decisions on an adhoc basis without the benefit of the explicit directions usually contained in the specifications. The composite of these decisions was a system which provided too many reports of minimal value, terminal functions which were not used, and which could not operate in a NATO environment.

Finally a comprehensive cost/benefit analysis was never performed to determine the true feasibility of the proposed systems. The high risk associated with the FCS was never fully recognized in the feasibility study. Alternative systems were not considered in the feasibility study. As a result of the above, the service wasted a lot of money while pursuing the development of a system which never materialized. The lack of alternative systems in the feasibility study deprived the Navy of the option to select a more appropriate design. Appendix (G) lists several of the alternative design options which were available for consideration.

B. RECOMMENDATIONS

More time needed to be spent in the planning phase to prepare a comprehensive Configuration Management Plan, Training Plan, Security Plan, and Integrated Logistic Support Plan. These documents would have provided quick reference for the project team to use when confronted with major decisions. The plans would have contained procedures for establishing a change control board and would have outlined the major project objectives for training, security, and logistics. Such detailed guidance was badly needed by the MPDS project team and would have prevented many of the problems which resulted from the adhoc decisions. [Ref. 63]

A Program Plan which provided for periodic reviews would also have been helpful to the project team. One of the functions of the review team would be to consider freezing the system/subsystem's design. Early freezing of the FCS design could have prevented that system's development from falling behind schedule.

Future computer system acquisitions should place heavy emphasis on preparing thorough and clear specifications. This could be accomplished by establishing a specification review team consisting of both system sponsors and technical users who will initially verify the original specification and who would later approve/disapprove specification changes. This would have prevented many of the problems which occurred in the MPDS project where the users and sponsors received a product which was different than they had requested.

Concise specifications have the advantage of focusing heavily upon the end product. Such focus tends to prevent the technicians from becoming overly intrigued with the technical sophistication of their system and forces them to concentrate on developing an end product which matches the specification. This procedure would limit or reduce the problem of acquiring extremely sophisticated hardware and software as the Navy did with MPDS because the developers would not be given a blank specification sheet where they could fill in the details.

To ensure compliance with the above objectives, it is recommended that Project Sponsors include them in the Letter of Instruction (LOI), which signals the beginning of the acquisition process. By placing these requirements at the on-set of the project, they will receive the attention that they require at the appropriate time.

APPENDIX A

AQM ADDITION DEVELOPMENT RISK ESTIMATES

Development Risk Function	Risk Estimate
QUALITY MONITORING SYSTEM	
Signal Sensor and Samplers	low
Scanner-Multiplexer Converter (A/O)	low
Frequency Monitoring System	low
Quality Monitoring Software	low*
Frequency Monitoring Software	low*

* Predicated upon the availability of adequate support software

APPENDIX B

AQM DIFFERENTIAL COST ESTIMATES

COST ELEMENTS	COST ($K)
QUALITY MONITORING SYSTEM	
Signal Sensors and Samplers	5
Signal Conditioners	7
Scanner Multiplexer	14
A/D Converter	1
Frequency Monitoring System	10
Installation	17
Quality Monitoring System Software	10
Frequency Monitoring System Software	15

Total=$79k

APPENDIX C

MQM/AQM CABABILITY/RISK/COST SUMMARY

System	Capability	Risk		Cost	
		operatn'l	devlpm't	hardwr.	soft wr.
Manual quality monit'g system (mqm)	Baseline	Baseline	Baseline	Baseline	--------
Automated Quality Monitor'g (AQM)	Baseline plus the following: 1. Continuous signal monitoring 2. Hardware or software alarm readout 3. Software changeable signal threshold 4. Frequency and equipments usage reports 5. Remote manual programs load, monitor and dump FMS operations 6. Automatic FMS carrier and audio freq accuracy measurements	Baseline Plus Computer system	LOW	Baseline Plus $54K	$25K

APPENDIX D

OPEN SCP'S MPDS CVN-68 CLASS

SCP REL 9.0	CANIDATE FOR RELEASE 10.0 Last CCB	CVN-68	CVN-69	CVN-70	Pre CCB	NTSIC	CCB	CNTC APPR
0002 #								
0003 #								
0004	X $	X			H $	H $	H $	
0005 #								
0006		C			H	H	H	
0007								
0008	X $	X			H $	H $	H $	
0009		C	X		C	C	C	
0010	X	X			X	X	X	
0011		X			X	X	X	
0012	X $	X			H $	H $	H $	
0014 #								
0016	X	C			C	C	C	
0017 ? $		X						
0018	X	X	X		X	X	X	
0019		X			C	C	C	
0020		C			C	C	C	
0023 #								
0025 #								
0026	X	C			C	C	C	
0027		X			C	H	H	
0030		C			C	H	H	

- Approved by last CCB for Rel 9.0
? - Request CNTC Approval for Rel 9.0
X - Recommended or Requested for Rel 10.0
H - Recommended for Hold Open
C - Recommended for Cancel
R - Review
$ - Require ECP

APPENDIX E

OPCAPEVAL TEST SCHEDULE OF EVENTS

DATE	TEST/EVENT
TEST PERIOD A	
20-22 Aug 1973	Interconnection Verification Test
23-24 Aug	On-Line Confidence Test Off-Line Confidence Test
25 Aug	Security Composite Test P-Series on System 10
26-28 Aug	OPCAP Phase III on System 10
29-30 Aug	System Debug System 11 Preventive Maintenance Test System 11
31 Aug	Security Composite Test P-Series on System 11
1-5 Sept	OPCAP Phase III Test on System 11
6-7 Sept	System debug System 11
8-10 Sept	Nimitz Crew Training
11-12 Sept	System Debug System 11
13-15 Sept	OPCAP Phase IV-A Test on System 11
16-18 Sept	OPCAP Phase IV-A Test on System 11
19-20 Sept	System Debug System 11
21-23 Sept	Contingency
24-30 Sept	Standard Measurement Technique (SMT)
24-27 Sept	Nimitz Crew Training
28-30 Sept	Contingency (End of Test Period A)
TEST PERIOD B	
1-6 Oct	OPCAP Phase IV Test Demonstration on System 11

APPENDIX F

NAVMACS HARDWARE MODULARITY MATRIX

EQUIPMENT	NAVMACS V1	NAVMACS V2	NAVMACS V3	NAVMACS V5
AN/UGC-25 PAGE PRINTER	4	-	-	-
AN/UGC-20 CONTROL TTY	1	1	-	-
AN/UYK-20 MINICOMPUTER	1	1	2	3
ON-143 INTERFACE GROUP	1	1	1	1/2
RD-397 PAPER TAPE READER PUNCH	1	1	1	2
CV-3022 LEVEL CONVERTER	1	1	2	2/3
AN/USH-26 MAGNETIC TAPE UNIT	-	1	2	2
TT-624 MEDIUM SPEED PRINTER	-	2	2	13/21
AN/USQ-69 KEYBOARD/DISPLAY	-	0/1/2	2/3	9/18
RD-433 DISK FILE	-	-	-	2
KEYBOARD/PRINTER	-	-	-	0/16

APPENDIX G

A. SYSTEM SELECTION

1. Basic Criterion

The most important decision that the Communication Planners had to make was concerning the selection of the type of system which they were going to develop for installation onboard the Nimitz. The system had to satisfy the major communications objectives of reducing human intervention, increasing processing speed, as well as being able to handle the extremely large volumes of message traffic normally associated with air craft carriers and their embarked Flag Officers' staffs. Important decisions had to be made concerning the number of manual activities to be automated, what functions should be placed online, and what processing speeds should be obtained.

2. Alternative Design Approaches

a. Semi-Automatic

The MPDS developed for the USS Oklahoma City (CG-5) is an example of a system which satisfied the stated objectives while using minimal hardware and software resources. The automated features of this system did not include remote terminal message and report retrieval services. Nor did it allow for remote terminal message transmission.

b. Fully Automated

The MPDS developed for the USS Nimitz offered maximum automation, high processing speeds, and very high message processing rates. The hardware and software were characterized by high interdependancies and sophistication.

c. Hybrid Approach

Many combinations of semi-automated and fully automated features were available for the planners to consider. Any system which performed the basic automated functions of the (CG-5) system would fall into this category.

3. <u>Advantages</u>

a. Semi-Automated System

The semi-automated system was built from existing hardware. It took minimal time to become fully operational. The cost to develop the CG-5 system was relatively low.

b. Fully Automated System

The CVN-68 system offered many online services to the users such as remote terminal message services [Ref. 60]. These services have increased user productivity and communications accuracy.

4. <u>Disadvantages</u>

a. Semi-Automated

This system requires a lot of manual intervention in the message handling process. The users have to walk their outgoing messages traffic to Radio Central. Message retrievals take a relatively long time to process.

b. Fully Automated

The primary disadvantages are high development cost and maintenance difficulties due to the high sophistication of the hardware and software.

5. <u>Planners' Choice</u>

The planners had to make a performance/cost tradeoff in selecting the communications system for MPDS. The decision to develop a highly automated system reflects the planners' emphasis on maximum performance.

B. HARDWARE AND SOFTWARE SELECTION

Another important area which was of concern to the planners was hardware and software selection. Plans had to be made outlining policy on the use of existing hardware and software. Decisions had to be made concerning what specifications would be used for items that had to be developed. The decisions made by the planners can be found in the

Military Specification and the Functional Description. The results of these decisions can be observed onboard the USS Nimitz and USS Eisenhower.

1. Utilize Existing Units

The planners decided to use existing equipment and design where they were available, for MPDS [Ref. 61]. The pieces of equipment which were to be used were listed in the Military Specifications.

2. Develop New Units

Another approach would have been to develop an entirely new suite of hardware and software.

3. Advantages

a. Utilize Existing Units

Several savings can be obtained by using existing units. The project can save a lot of time and money by not having to develop a new unit. The amount of risk involved in the development is also much lower when one has a known reliable unit in stock.

b. Develop New Units

The major advantage to developing new units is increase in performance.

4. Disadvantages

a. Utilizing Existing Units

The existing units may be functioning below the standards of the new equipment. Opportunities for improved performance may be lost because outdated units are not replaced by more efficient/effective units.

b. Develop New Units

New developments often run a high degree of risk which could result in a late delivery. New units often run up the cost of the project.

5. Major Decisions

Again the planners were required to make judgemental decisions about performance/cost trade-offs. Since new units usually increased both performance and cost, and existing units tended to reduce project cost, the planners had to select the appropriate trade-offs.

The planners' decision to use existing units for MPDS proved to be a wise one since the new units experienced a lot of logistic problems [Ref. 62].

LIST OF REFERENCES

1. Naval Electronics Laboratory Center, Functional Description Message Processing and Distribution System (MPDS) for CVN 68, 1 September 1972.

2. Syncrotech Software Corporation, Letter to Lt. R. Botwright, Code 521, Subject: Trip Report for E. Ogota and T. Struck onboard USS Nimitz 25 November-13 December, 23 December 1977.

3. Naval Telecommunications System Integration Center, Conversation with LCDR R. Botwright, Fleet Software Maintenance Department Head, NAVELEX (510XA), 5 March 1981.

4. Nav l Telecommunications System Integration Center, CVN-68 Class MPDS History, January 1981

5. Op. Cit., Botwright.

6. Department of the Navy Military Specification MIL-M-24281 (SHIPS), Military Specification Message Processing and Distribution System AN/SYQ-6(XG-1)(V) (for CVAN 68), 30 January 1967.

7. Nav l Electronics Command, Conversation with Bill Wilcox, MPDS Acquisition Engineer NAVELEX (510), 22 January 1981.

8. Op. Cit., Ref. 6.

9. Op. Cit., Ref. 6.

10. Naval Ocean Systems Center, Letter to Lt. Kenneth L. Whitten, Subject: MPDS Development, 5 March 1981.

11. Naval Telecommunications System Integration Center, Conversation with CDR Franson, Deputy Director Naval Telecommunications System Integration Center, NAVELEX (510X1), 4 March 1981.

12. Naval Ocean Systems Center, Conversation with Bruce Cranmore, NOSC Code (8141), 10 January 1981.

13. Op. Cit., Cranmore.

14. Op. Cit., Ref. 6.

15. Op. Cit., Botwright.

16. Op. Cit., Ref. 6.

17. Fleet Combat Direction Systems Support Activity Operations Manual PD(P)-6140, Volume 1, 20 August 1973.

18. Donovan, J.J. and Madnick, L.E., Operating Systems, Ch. 2, McGraw-Hill, 1974.

19. Schell, R.R., "Computer Security, the Achilles' Heel of the Electronic Air Force," Air University Review, Volume XXX No. 2, January-February 1979.

20. Ibid.

21. Op. Cit., Wilcox.

22. Op. Cit., Franson.

23. Planning Research Company, Integrated of Communications System Studies, Volume II, June 1970.

24. Fried, L., Practical Data Processing Management, Prentice Hall, Incorporated, 1979.

25. Op. Cit., Botwright.

26. Op. Cit., Botwright.

27. Op. Cit., Botwright.

28. Op. Cit., Franson.

29. Naval Electronic Systems Command, Report of Special Testing of MPDS Broadcast Screening Capabilities, 23 May 1973.

30. Naval Electronic Systems Command, MPDS AN/SYQ-6 (XG-1) Systems Improvement Test Three, 17 April 1973.

31. Briggs, C.L., Birks, E.G., and Atkins, W., Managing the Systems Development Process, Prentiss Hall, Inc., 1980.

32. Ibid.

33. Fleet Combat Direction System Support Activity, Letter 12: PW 3900: Serial 46 to Naval Electronic Systems Command, Subject: MPDS Suite at FCDSSASD: logistics support, 12 January 1977.

34. Op. Cit., Ref. 4.

35. Op. Cit., Botwright.

36. Op. Cit., Botwright.

37. Naval Electronic Systems Command, Execution Plan for Operational Capability Evaluation (OPCAPEVAL), July 1972.

38. Syncrotech Software Corporation, Letter to Lt. R. Botwright, Code 521, Subject: Trip Report for E. Ogota and F. Struck Onboard USS Nimitz, 23 November - 13 December, 23 December 1977.

39. Commander Task Force Six Zero, message 281942ZJUL76.

40. Op. Cit., Franson.

41. Naval Electronic Systems Command, Naval Modular Automated Communications System (NAVMACS), 23 July 1977.

42. Op. Cit., Franson.

43. Op. Cit., Franson.

44. Commander Carrier Group Two, Letter FB2/11: was 2000: Serial C5 to Commander Naval Air Force, U.S. Atlantic Fleet, Subject: Message Processing and Distribution System (MPDS), 14 March 1977.

45. Supervisor of Shipbuilding Newport News, Letter to Admiral Kidd, Subject: MPDS Logistics, 6 December 1974.

46. Fleet Combat Direction System Support Activity, Letter 12: PW 3900: Serial 46 to Naval Electronic Systems Command, Subject: MPDS Suite at FCDSSASD: logistics support, 12 January 1977.

47. Fleet Combat Direction Systems Support Activity, Letter 5: RMI 5230: Serial 464 to Commander Naval Electronic Systems Command, Subject: Message Processing and Distribution System (MPDS), 4 April 1978.

48. Planning Research Company, Conversation with Lee Torgensen, Project Manager, 10 February 1981.

49. Op. Cit., Botwright.

50. Op. Cit., Ref. 44.

51. Naval Electronics Laboratory Center, Functional Description Message Processing and Distribution System (MPDS) for CVAN 58, 1 September 1972.

52. Commander Task Force Six Zero, message 091200ZFEB77.

53. Ibid.

54. Op. Cit., Ref. 6.

55. Op. Cit., Botwright.

56. Syncrotech Software Corporation, Letter to LCDR Maxwell, Subject: Trip Report for S. Chodos and T. Struck 1-10 August 1976 onboard USS Nimitz, 15 August 1976.

57. Op. Cit., Fried.

58. Syncrotech Software Corporation, Letter to Lt. R. Botwright, Code 521, Subject: Trip Report for E. Ogota and T. Struck onboard USS Nimitz 25 November-13 December, 23 December 1977.

59. Op. Cit., Ref. 6.

60. Op. Cit., Ref. 17.

61. Op. Cit., Ref. 6.

62. Op. Cit., Franson.

63. Jensen, R.W. and Tonies, C.C., Software Engineering, p. 40-46, Prentice-Hall, 1979.

INITIAL DISTRIBUTION LIST

		No. Copies
1.	Defense Technical Information Center Cameron Station Alexandria, Virginia 22314	2
2.	Library, Code 0142 Naval Postgraduate School Monterey, California 93940	2
3.	Professor Lyle Cox, 52Lb, Department of Computer Science Naval Postgraduate School Monterey, California 93940	4